Appendix C7. Summer Juvenile Salmonid Population Estimates

CONTENTS

Tables

C7.1 INTRODUCTION

In 1995, data collection on the summer populations of juvenile coho salmon and 1+ and older steelhead was initiated in three Plan Area streams: South Fork of the Winchuck River (Smith River HPA), Wilson Creek (Smith River HPA), and Cañon Creek (Mad River HPA). Since 1995, data collection has occurred annually on these three original creeks for chinook salmon, and cutthroat trout in addition to coho salmon and steelhead. Four more creeks were added in 1998: Hunter Creek (Coastal Klamath HPA); Lower South Fork Little River, Railroad Creek, and Upper South Fork Little River (all Little River HPA). Sullivan Gulch (North Fork Mad River HPA) was added to the program in 1999. The purpose of these population surveys is to estimate and monitor summer populations of young-of-the-year coho salmon, chinook salmon, steelhead and cutthroat trout. Dive counts estimate salmonid population size during summer low flow periods (August-September). These fish represent the population of juvenile salmonids that will be shortly out-migrating or over-wintering in Plan Area streams.

C7.2 METHODS

The 1995 effort was part of a pilot study to test and refine a sampling methodology developed by Drs. Scott Overton and David Hankin in conjunction with funding through the Fish, Farm and Forest Communities Forum (FFFC). Juvenile salmonid population sampling has evolved since the program's inception in 1995. The population estimate methodology was based on the Hankin and Reeves (1988) two-phase survey design, with the most recent modifications being incorporated from Hankin (1999). These changes have been adopted to improve statistical validity, reduce variance, increase efficiency in the field, and reduce electrofishing effort. The current protocol is especially appropriate for small streams containing special status species where injury and mortality are a concern from a federal Endangered Species Act "take" stand-point.

The current protocol allows for increased use of diver counts for estimating the abundance of juvenile salmonids in streams. This approach reduces the need for electrofishing and related possible mortality of special status species (e.g. coho salmon).

The first phase of the current sampling design classifies habitat units into riffles, runs, pools, and deep pools, measures dimensions of each unit, and then randomly selects a fraction of units in each habitat class for phase 1 sampling (employing the Adaptive Sequential Independent Sampling [ASIS] method [Hankin 1999]). ASIS is used in first and second phase unit selection permitting habitat mapping and unit selection decisions to be made in the field. Phase 1 sampling consists of diving each selected unit to obtain an initial count of salmonids within the sampling unit. Riffle segments are electrofished as diving cannot be conducted in riffles. A subset of the sampled units is then randomly selected for calibration using the ASIS method. The mode of calibration (2^{nd} phase sampling) is determined by the number of individuals counted in each unit. If the initial dive count is less than 20 individuals (of a given species), calibration is conducted by Method of Bounded Counts (Robson and Whitlock 1964). The Method of Bounded Counts (MBC) is utilized to calibrate dive counts when the unit population size is small ($n<20$), producing a substantial reduction in electrofishing effort. If the initial dive count of the target species exceeds 20 fish, calibration is made by four-pass removal electrofishing method. Calibration within deep-pool stratums is made only by MBC, as

electrofishing is inefficient in this habitat stratum. In riffles selected for calibration, a 2 to 3 pass-removal electrofishing method is the mode of calibration.

If the method of bounded counts is the mode of calibration the 3 additional diver counts are made immediately following the 1 phase dive counts. If the 2nd phase sampling is conducted by the 4 pass-removal electrofishing method the electrofishing is conducted within no more than 2 days following phase 1 sampling. The methods employed for sample selection and estimation, the ASIS methodology, and phase 2 calibration methods are those of Hankin (1999). Additional discussion of the applicability and assumptions of the population estimation methodology employed by Green Diamond are found in Hankin (1999).

This protocol has also been slightly modified from previous years to provide more consistency between individual crews and from year to year. In the past, the difference between a deep pool and a shallow pool was based on processional judgment on whether or not the habitat mapping crew thought it possible to effectively electrofish a particular unit. If a pool was considered to be too complex; i.e. too much large woody debris (LWD), small woody debris (SWD), or deep undercut banks, it was classified as a deep pool and only calibrated by repeated dive counts.

Since 1999, pools less than 1.1 meters in depth are considered shallow pools and pools greater than or equal to 1.1 meters in depth are considered deep pools regardless of cover. This provided better consistency between crews, allowing comparisons of population estimates between different streams, crews, and property owners. The reduction in total number of deep pools and the corresponding increase in shallow pools is a result of this protocol change and not in the quality or quantity of available habitat. Green Diamond believes that this change to the protocol has also provided a much better estimate due to the increased number of calibrated shallow pools. The complexity of the pool does not appear to influence the ability to effectively electrofish those units.

C7.3 RESULTS

The summarized results of the summer juvenile population estimates for the 8 Plan Area streams are presented in Tables C7-1 through C7-4. The summer juvenile population estimates and the (+/-) 95% confidence interval (C.I.) for coho salmon for the years 1995 through 2000 are shown in Table C7-1. Table C7-2 summarizes the summer juvenile population estimates and (+/-) C.I.s for steelhead for the years 1995 through 2000. Tables C7-3 and C7-4 provide summaries of juvenile summer population estimates and corresponding (+/-) 95% C.I.s for cutthroat trout and chinook salmon respectively, for the years 1996 through 2000.

C7.4 DISCUSSION

C7.4.1 Methodology Effectiveness

The modified Hankin and Reeves juvenile sampling protocol has worked well for estimating juvenile coho salmon and 1+ steelhead populations. Consideration early in the development of the protocol was also given to cutthroat and chinook. Including cutthroat and chinook as species accounted for in the survey methodology has presented some complications, which are apparent looking at data collected from 1995 to 2000.

Table C7-1. Summer juvenile coho population estimates in eight Plan Areas streams, 1995-2000.

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
SF Winchuck River	1995	DP, SP, Run, Riffle	Unable to be estimated	
	1996	DP	32	23
		SP, Run, Riffle	4*	n/a
			Total 36	
	1997	DP	156*	n/a
		SP, Run, Riffle	331	140
			Total 487	
	1998	DP	33	7
		SP, Run, Riffle	0	0
			Total 33	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
Wilson Creek	1995	DP, SP, Run, Riffle	1370†	212
	1996	DP	357	116
		SP, Run, Riffle	164	123
			Total 521	
	1997	DP	209*	n/a
		SP, Run, Riffle	27*	n/a
			Total 236	
	1998	DP	355	108
		SP, Run, Riffle	25	22
			Total 380	
	1999	DP	0	0
		SP, Run, Riffle	19	21
			Total 19	
	2000	DP	21	18
		SP, Run, Riffle	23	23
			Total 44	
Hunter Creek	1998	DP	317	122
		SP, Run, Riffle	81	88
			Total 398	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
Railroad Creek (Little River)	1998	DP	85	34
		SP, Run, Riffle	164	84
			Total 249	
	1999	DP	0	0
		SP, Run, Riffle	339	64
			Total 339	
	2000	DP	14*	n/a
		SP, Run, Riffle	162	79
			Total 176	

Table C7-1 Continued. **Summer juvenile coho population estimates in eight Plan Areas streams, 1995-2000.**

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
Lower SF Little River	1998	DP	2,397	282
		SP, Run, Riffle	1,213	312
			Total 3,610	
	1999	DP	1,774	253
		SP, Run, Riffle	6,129	883
			Total 7,903	
	2000	DP	1,403	232
		SP, Run, Riffle	3,364	761
			Total 4,767	
Upper SF Little River	1998	DP	265	101
		SP, Run, Riffle	473	186
			Total 738	
	1999	DP	182	134
		SP, Run, Riffle	1,048	484
			Total 1,230	
	2000	DP	68	89
		SP, Run, Riffle	275	83
			Total 343	
Sullivan Gulch	1999	DP	147	30
		SP, Run, Riffle	636	265
			Total 783	
	2000	DP	10*	n/a
		SP, Run, Riffle	41	37
			Total 51	
Cañon Creek	1995	DP, SP, Run, Riffle	919†	377
	1996	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1997	DP	20*	n/a
		SP, Run, Riffle	23	36
			Total 43	
	1998		Not Estimate Made	
	1999	DP	231	101
		SP, Run, Riffle	179	89
			Total 410	
	2000	DP	160	47
		SP, Run, Riffle	123	38
			Total 283	

Notes
* Units not calibrated or no fish observed in calibration units making an estimate impossible. These numbers are a sum of fish observed in non-calibrated units.
† Estimate from Chris Moyer's thesis work.

Table C7-2. Summer juvenile steelhead population estimates in eight Plan Area streams, 1995-2000.

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
SF Winchuck River	1995	DP, SP, Run, Riffle	932†	332
	1996	DP	1,092	145
		SP, Run, Riffle	822	150
			Total 1,914	
	1997	DP	237*	n/a
		SP, Run, Riffle	619	230
			Total 856	
	1998	DP	1,459	189
		SP, Run, Riffle	1,069	206
			Total 2,528	
	1999	DP	327	71
		SP, Run, Riffle	768	101
			Total 1,095	
	2000	DP	1,205	175
		SP, Run, Riffle	2,028	463
			Total 3,233	
Wilson Creek	1995	DP, SP, Run, Riffle	1,041†	253
	1996	DP	909	189
		SP, Run, Riffle	960	348
			Total 1,869	
	1997	DP	146*	n/a
		SP, Run, Riffle	100	21
			Total 246	
	1998	DP	875	177
		SP, Run, Riffle	544	96
			Total 1,419	
	1999	DP	331	153
		SP, Run, Riffle	410	124
			Total 741	
	2000	DP	365	149
		SP, Run, Riffle	932	148
			Total 1,297	
Hunter Creek	1998	DP	1,012	351
		SP, Run, Riffle	790	154
			Total 1,802	
	1999	DP	130	42
		SP, Run, Riffle	745	123
			Total 875	
	2000	DP	815	270
		SP, Run, Riffle	1,206	394
			Total 2,021	
Railroad Creek (Little River)	1998	DP	35	54
		SP, Run, Riffle	80	44
			Total 115	
	1999	DP	12	9
		SP, Run, Riffle	64	24
			Total 76	
	2000	DP	5*	n/a
		SP, Run, Riffle	72	35
			Total 77	

Table C7-2 Continued. **Summer juvenile steelhead population estimates in eight Plan Areas streams, 1995-2000.**

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
Lower SF Little River	1998	DP	176	61
		SP, Run, Riffle	54	31
			Total 230	
	1999	DP	56	20
		SP, Run, Riffle	157	42
			Total 213	
	2000	DP	23	19
		SP, Run, Riffle	39	17
			Total 62	
Upper SF Little River	1998	DP	132	28
		SP, Run, Riffle	218	55
			Total 350	
	1999	DP	50	11
		SP, Run, Riffle	168	66
			Total 218	
	2000	DP	16	28
		SP, Run, Riffle	236	55
			Total 252	
Sullivan Gulch	1999	DP	10	4
		SP, Run, Riffle	7	8
			Total 17	
	2000	DP	2*	n/a
		SP, Run, Riffle	55	21
			Total 57	
Cañon Creek	1995	DP, SP, Run, Riffle	1,041†	253
	1996	DP	359	99
		SP, Run, Riffle	317	69
			Total 676	
	1997	DP	90	n/a
		SP, Run, Riffle	508	106
			Total 598	
	1998		No Estimate made	
	1999	DP	197	53
		SP, Run, Riffle	375	121
			Total 572	
	2000	DP	348	70
		SP, Run, Riffle	585	93
			Total 933	

Notes
* Units not calibrated or no fish observed in calibration units making an estimate impossible. These numbers are a sum of fish observed in non-calibrated units.
† Estimate from Chris Moyer's thesis work.

Table C7-3. Summer juvenile coastal cutthroat trout population estimates in eight Plan Area streams, 1995-2000.

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
SF Winchuck River	1995	DP, SP, Run, Riffle	No Estimate Made	
	1996	DP	299	56
		SP, Run, Riffle	131	25
			Total 430	
	1997	DP	56*	n/a
		SP, Run, Riffle	331	140
			Total 487	
	1998	DP	283	67
		SP, Run, Riffle	194	39
			Total 477	
	1999	DP	115	32
		SP, Run, Riffle	265	66
			Total 380	
	2000	DP	172	50
		SP, Run, Riffle	302	123
			Total 474	
Wilson Creek	1995	DP, SP, Run, Riffle	No Estimate Made	
	1996	DP	120	47
		SP, Run, Riffle	38	16
			Total 158	
	1997	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1998	DP	27	19
		SP, Run, Riffle	3	4
			Total 30	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	15	15
		SP, Run, Riffle	0	0
			Total 15	
Hunter Creek	1998	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	35	25
		SP, Run, Riffle	15	10
			Total 50	
Railroad Creek (Little River)	1998	DP	0	0
		SP, Run, Riffle	10	6
			Total 10	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	

Table C7-3 Continued. Summer juvenile coastal cutthroat trout population estimates in eight Plan Areas streams, 1995-2000.

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
Lower SF Little River	1998	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1999	DP	0	0
		SP, Run, Riffle	82	22
			Total 82	
	2000	DP	1*	n/a
		SP, Run, Riffle	18†	17
			Total 19	
Upper SF Little River	1998	DP	1*	n/a
		SP, Run, Riffle	6	7
			Total 7	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	0	0
		SP, Run, Riffle	4	13
			Total 4	
Sullivan Gulch	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
Cañon Creek	1995	DP, SP, Run, Riffle	No Estimate Made	
	1996	DP	13	13
		SP, Run, Riffle	0	0
			Total 13	
	1997	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1998		No Estimate Made	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	17	11
		SP, Run, Riffle	4	4
			Total 21	

Notes
* Units not calibrated or no fish observed in calibration units making an estimate impossible. These numbers are a sum of fish observed in non-calibrated units.
† Estimate made using data from electro-fishing

Table C7-4. Summer juvenile chinook population estimates in eight Plan Area streams, 1995-2000.

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
SF Winchuck River	1995	DP, SP, Run, Riffle	No Estimate Made	
	1996	DP	313	101
		SP, Run, Riffle	35	13
			Total 348	
	1997	DP	12*	n/a
		SP, Run, Riffle	85	17
			Total 97	
	1998	DP	688	232
		SP, Run, Riffle	220	163
			Total 908	
	1999	DP	496	208
		SP, Run, Riffle	899	156
			Total 1,395	
	2000	DP	66	26
		SP, Run, Riffle	42	30
			Total 108	
Wilson Creek	1995	DP, SP, Run, Riffle	No Estimate Made	
	1996	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1997	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1998	DP	3*	n/a
		SP, Run, Riffle	8	13
			Total 11	
	1999	DP	1*	n/a
		SP, Run, Riffle	0	0
			Total 1	
	2000	DP	0	0
		SP, Run, Riffle	1*	n/a
			Total 1	
Hunter Creek	1998	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1999	DP	30	37
		SP, Run, Riffle	26	34
			Total 56	
	2000	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
Railroad Creek (Little River)	1998	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	

Table C7-4 Continued. **Summer juvenile chinook population estimates in eight Plan Areas streams, 1995-2000.**

Stream	Year	Habitat	Population Estimate	95% C.I. (+/-)
Lower SF Little River	1998	DP	4*	n/a
		SP, Run, Riffle	0	0
			Total 4	
	1999	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	2000	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
Upper SF Little River	1998	DP	0	0
		SP, Run, Riffle	0	0
			Total 0	
	1999	DP	0	0
		SP, Run, Riffle	2*	n/a
			Total 2	
	2000	DP	0	0
		SP, Run, Riffle	6	19
			Total 6	
Sullivan Gulch	1999	DP	2	2
		SP, Run, Riffle	1*	n/a
			Total 3	
	2000	DP	4*	n/a
		SP, Run, Riffle	8	10
			Total 12	
Cañon Creek	1995	DP, SP, Run, Riffle	No Estimate Made	
	1996	DP	23	37
		SP, Run, Riffle	0	0
			Total 23	
	1997	DP	8*	n/a
		SP, Run, Riffle	8	18
			Total 16	
	1998		No Estimate Made	
	1999	DP	249	208
		SP, Run, Riffle	89	48
			Total 338	
	2000	DP	28	15
		SP, Run, Riffle	44	46
			Total 72	

Note
* Units not calibrated or no fish observed in calibration units making an estimate impossible. These numbers are a sum of fish observed in non-calibrated units.

Juvenile population estimates within Plan Area streams continue to include estimates for juvenile chinook (0+) and 1+ cutthroat. Chinook population estimates are relatively small compared to coho and steelhead. In the Plan Area, the majority of the chinook out-migrate before summer low flow conditions are reached, making it difficult to sample a closed population.

Cutthroat greater than 1+ years of age are included in the population estimate, although small populations and species migration patterns may complicate the estimation methodology. Both cutthroat and steelhead can sometimes be difficult to distinguish as young of the year or 1+ fish. Generally, when cutthroat reach a size greater than 120mm, they are easily distinguished from steelhead. By inaccurately distinguishing between "trout" life history stages, the methodology may underscore year class population size and may potentially underestimate or overestimate steelhead and/or cutthroat populations within Plan Area streams that contain sizeable runs of either species. A second concern for estimating cutthroat populations can be drawn from juvenile out-migration trapping results obtained from the Little River drainage. As seen during juvenile out-migrant trapping, a large number of parr and pre-smolting cutthroat are observed moving through the traps during late winter and fall. Steelhead of similar age classes are also observed moving through the traps. The summer population estimates, only include those cutthroat or steelhead that remain in the streams throughout the year. It is possible that the "trout" population is underestimated because a large proportion of the population left the system during winter and fall prior to conducting the summer population estimate. A third concern when applying this methodology to "trout" is the approachability of the species through diver observation. Unlike coho salmon, "trout" are skittish and hide as a diver approaches, making counts difficult and identification sometimes impossible. During Phase 2 calibration, this can affect MBC, which relies on a surveyor's ability to observe the same fish on subsequent dives.

C7.4.2 Population Size

Juvenile coho population estimates from the Plan Area vary from stream to stream and year to year. In data sets that span a period of five years, juvenile coho population estimates vary widely; increasing in some streams and decreasing in others. Overall, Plan Area streams north of Redwood Creek show a downward progression in coho populations (Table C7-1). Data collected from streams south of Redwood Creek show relatively stable or increasing populations. Studies within these streams have not occurred long enough to infer trends; however, factors such as low winter flows and poor ocean conditions can contribute to poor adult escapement. This observation is supported by spawning surveys that occur within Plan Area streams, which documented little to no returning adult coho. These observations do not always hold true as is discussed under the Spawning Survey section of Appendix C, however, it can help to explain population estimates that observed no coho salmon in some north Plan Area streams (S.F. Winchuck and Hunter Creek).

Steelhead estimates indicate stable or increasing populations both north and south of Redwood Creek (Table C7-2). Juvenile populations within streams north of Redwood Creek tend to show the highest population estimates. Within these streams, habitat conditions may be more suited for this species that has behaviors adapted for swift flowing, higher gradient watercourses, with reduced velocity refuge.

Juvenile cutthroat populations tend to show very limited numbers within Plan Area streams, other than the SF Winchuck. However, presence/absence surveys indicate that cutthroat are widely dispersed across the Plan Area. Cutthroat trout populations tend to decrease south of Redwood Creek and disappear from state records south of the Eel River (Gerstung 1997). Populations of cutthroat trout that often prefer low velocity habitats, may out compete coho within areas like the S.F. Winchuck.

Juvenile chinook salmon tend to out-migrate from Plan Area streams prior to June. The juvenile dive counts take place in the months of August and September during summer low flow. Residual populations of chinook salmon counted during the summer dives demonstrate species presence, but cannot be used for population estimates due to their early season out-migration patterns.

C7.4.3 Summer Habitat Preference

During summer low flows, pool habitat is the preferred habitat type for all species (Tables C7-1 through C7-4), specifically deep pools. Species competition within this habitat type becomes apparent in high production years or in small streams with limited pool habitat available. Other habitat types such as runs and shallow pools are well utilized by all species. Depending on the amount of available habitat during high production years, juvenile coho salmon can be found distributed in all habitat types including riffles. This is likely a result of fully seeded habitats, where intraspecific competition causes redistribution among available habitat types even into “less desirable” rearing habitats such as riffles. In lower production years, such as 2000, coho salmon may be out competed by steelhead or cutthroat trout for deep pool habitat.

C7.5 CONCLUSIONS

Using this protocol to estimate juvenile chinook populations is not recommended, but may work for more northern populations (British Columbia and Alaska) that over-winter in freshwater. It is also not well suited for cutthroat trout due to their limited numbers within Plan Area streams and their tendency to move downstream of survey reaches prior to summer low flows. Overall, juvenile population sampling using the modified Hankin and Reeves survey methodology is very useful for estimating juvenile coho populations, and appears to be well suited for 1+ steelhead trout, although significant numbers of steelhead can be observed moving downstream prior to summer surveys. Juvenile coho are generally unafraid of divers and are very approachable. Identification is simple, using both physical attributes and their distinct behavior as key identifiers. Steelhead are skittish and not often seen during subsequent Phase 2 calibration dives, never-the-less 95% C.I. indicate limited variation among population estimates for this species.

Juvenile coho populations within the Little River watershed appear stable and well seeded in all three-survey years, and in the majority of Little River tributaries. Population estimates north of Little River may reflect habitat conditions more suitable for steelhead, however many other factors including adult escapement and interspecific competition could account for the observed estimates. Steelhead 1+ juveniles appear to be distributed in sizable numbers in all surveyed Plan Area streams. While changes (positive or negative) in summer population estimates is clearly of interest, it remains unclear what, if any, changes can be related to management. Currently, population trends cannot be inferred from available data for any of the species, however these

estimates may help determine relationships between coho populations in different streams throughout the Plan Area, and the climactic and/or habitat conditions which affect summer population size, when combined with other monitoring efforts.

C7.6 REFERENCES

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